

SECTION 17

HEATING SYSTEMS: FORCED-WARM AIR

17-01 SCOPE: The work covered by this section of the specifications consists in furnishing all plant, labor, equipment, appliances and materials not furnished by the Government and in performing all operations in connection with the installation of the forced-warm air heating systems, complete, in strict accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the contract.

17-02 APPLICABLE SPECIFICATIONS: The following specifications, standards and publications of the issues listed below but referred to thereafter by basic designations only, form a part of this specifications:

a. Federal Specifications:

HH-B-671c	Brick; Fire-Clay
HH-C-451b	Clay; Fire, Ground
HH-I-561c	Insulation; Thermal, Asbestos
HH-I-564	Insulation; Mineral-Wool, Block and Board (for Heated Surfaces)
HH-I-578a	Insulation, Vermiculite; Block and Pipe-Covering (Molded)
QQ-A-359b	Aluminum-Alloy (Al-3) (Aluminum-Manganese); Plate and Sheet
QQ-I-716	Iron and Steel; Sheet, Zinc-Coated (Galvanized)
QQ-S-636	Steel; Carbon (Low-Carbon), Sheets and Strips
TT-V-51a	Varnish; Asphalt
WW-V-54	Valves, Bronze, Gate; 125- and 150-Pound Screwed and Flanged (for Land Use)
WW-T-799	Tubing; Copper, Seamless (for use with solder joint)
GGG-P-351a	Pipe-Threads; Taper (American-National)

b. U. S. Department of Commerce Commercial Standard:

CS75-42	Automatic-Mechanical-Draft Oil Burners Designed for Domestic Installations
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c. National Association of Fan Manufacturers, Inc. Bulletin:

Nr. 110 Standards, Definitions, Terms and
Tests Codes for Centrifugal, Axial
and Propeller Fans (1950)

d. National Board of Fire Underwriters Pamphlets:

Nr. 31 Oil Burning Equipments (1950)

Nr. 90 Air Conditioning, Warm Air Heating,
Air Cooling and Ventilating Systems
(1950; Amendment 1950)

17-03 GENERAL: The contract drawings indicate the extent and general arrangement of the heating systems. If any departures from the contract drawings are deemed necessary by the Contractor, details of such departures and the reasons therefor shall be submitted as soon as practicable to the Contracting Officer for approval. No such departures shall be made without the prior written approval of the Contracting Officer. The warm-air heating installation shall conform to Pamphlet Nr. 90 of the National Board of Fire Underwriters.

a. Standard Products: All equipment, valves controls and material, to be furnished under this specification shall be the standard products of approved American manufacturers. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the systems need not be the products of the same manufacturer.

b. Material and Equipment Schedule: Within 45 days after the date of award of contract and before purchase of any material or equipment, a complete schedule of the Contractor-furnished material and equipment proposed for installation shall be submitted for the approval of the Contracting Officer. The schedule shall include catalogs, performance data, cuts, control diagrams, drawings, and any such other descriptive data as may be required by the Contracting Officer. In the event any items of materials of equipment contained in the schedule fail to comply with the specification requirements, such items may be rejected.

c. Options of the Government: If the Contractor fails to submit for approval within the specified time or any authorized extension thereof, a list of materials, fixtures and equipment in accordance with the preceding paragraph, the Contracting Officer may select a complete line of materials, fixtures and equipment. The selection made by the Contracting Officer shall be final and binding and the items shall be furnished and installed by the Contractor without change in the contract price or time of completion.

17-04 MATERIALS AND EQUIPMENT: The following materials and equipment shall conform to the respective specifications and other requirements specified below:

a. Aluminum Sheets: Federal Specification QQ-A-359, quarter-hard condition.

b. Asphalt Varnish: Federal Specification TT-V-51.

c. Copper Tubing: Federal Specification WW-T-799, type K.

d. Electrical Materials and Appliances: ELECTRICAL WORK; INTERIOR, of these specifications.

e. Firebrick: Federal Specification HH-B-671, low-heat duty.

f. Fire Clay: Federal Specification HH-C-451, class C.

g. Galvanized Iron or Steel Sheets: Federal Specification QQ-I-716, class D1.

h. Gate Valves: Federal Specification WW-V-54, class A.

i. Insulation: Mineral-wool board or blocks conforming to Federal Specification HH-I-564, class A, vermiculite blocks conforming to Federal Specification HH-I-578; type IV, or asbestos block conforming to Federal Specification HH-I-561, type I.

j. Mechanical Equipment: All items of mechanical equipment shall be of the best quality normally used for the purpose in good commercial practice and shall be the products of approved reputable American manufacturers. Each major component of equipment shall have the manufacturer's name, address and catalog number on a name plate securely affixed in a conspicuous place. The name plate of distributing agent only will not be acceptable. Belts, pulleys, chains, gears, couplings, projecting set screws, keys and other rotating parts located so that any person may come in close proximity thereto shall be fully enclosed or properly guarded.

k. Pipe Fittings: Federal Specification WW-P-521, class as required to match adjacent piping.

l. Steel Pipe: Federal Specification WW-P-406, type I, class A, coating as hereinafter specified.

m. Unions: Federal Specification WW-U-531, class as required to match adjacent piping.

17-05 WORKMANSHIP: Equipment shall be installed in accordance with the recommendations of the manufacturer and the best standard practice for this type of work.

a. Pipe Threads: Pipe threads shall conform to the requirements of Federal Specification GGG-P-351.

17-06 FORCED WARM AIR FURNACE UNIT:

a. General: The furnace shall be ~~air-tight~~ ~~indicated on~~, the drawings, of the size and capacity not less than that indicated on the drawings when fired with Marine Class I, Diesel oil. All materials necessary for proper assembly shall be furnished with each furnace. When furnace casings, blowers, motors and other parts of equipment are shipped unassembled, all parts shall have been made so as to permit field assembly without grinding, drilling or similar work. Each furnace shall fit the space in which it is to be installed so as to allow ample room for maintenance. The furnace shall have combustion spaces designed to withstand possible explosions resulting from delayed ignition of the oil. The unit shall be approved by the Underwriters' Laboratories, Inc., and shall be of U. S. manufacture.

b. Heat Exchanger: Heat exchanger shall have a higher efficiency of heat transfer between the products of combustion and the circulated air for heating. The gas passages shall be designed to minimize air friction. The heat exchanger shall be so constructed so that the warm air for heating will not be subject to contamination with the products of combustion. The heat exchanger shall be designed to allow the metal to expand or contract without causing damage to any part, and shall be constructed of steel and cast iron of suitable composition and weight.

c. Combustion chamber shall be constructed of steel, cast-iron, refractory or a combination of these materials. Low carbon steel or cast iron used in the combustion chamber shall be protected with not less than 2 inches of refractory in areas where flame impingement may occur. The use of protecting refractory is not required for stainless steel, combustion chambers, unless surface temperatures of the steel exceeds 90% of the scaling temperature (degree F). The necessary pressure relief openings shall be provided to safeguard the furnace against explosion damage due to delayed ignition.

d. Cabinet encasing of the heat exchanger shall be properly insulated, and protected against corrosion by means of enamel or other suitable heat resisting protective finish. Galvanized-iron liners forming 1-inch air spaces will be considered as complying with the requirements for insulated cabinets. The cabinets shall be constructed of sheet metal not lighter than 0.0179 inch (26 gage) in thickness, and shall be provided with suitable duct connection openings.

e. Supply-Fan Unit: Supply-fan units shall be installed at the return side of the furnace and shall have a capacity not less than shown on the drawings. The fan unit shall be encased in a rigid housing designed to contain both fan and filters. The static pressure indicated on the drawings for the fan shall be considered as representing the pressure loss through the ductwork only, and shall be increased adequately to compensate for the loss through the furnace and filters. Fan shall be rated and constructed in accordance with Bulletin Nr. 110 of the National Association of Fan Manufacturers, Inc. The fan shall be mounted on approved sound-absorbing foundation pads, and shall be practically noiseless in operation.

The Contractor shall submit printed catalog evidence showing that the fan capacity and speed is certified for quiet operation. Impeller wheels shall be the multi-blade type, heavily and rigidly constructed. Each wheel shall be supported by two bearings, and shall be accurately balanced both statically and dynamically. Fans may be either directly or indirectly connected to the driving electric motors. V-belt drives shall be designed for at least 50-percent overload capacity, and shall be provided with convenient means of tightening or replacement. Electric motors shall be an open type, suitable for the available electric service, and provided with thermal-overload protection. Motors shall conform to the requirements of the section on ELECTRICAL WORK: INTERIOR, of these specifications.

f. Air Filters: Throw-away-type air filters 2 inches thick shall be installed. Convenient means of replacing the air filters in the installation conditions shown on the drawings shall be provided.

17-07 OIL-BURNING EQUIPMENT: Oil-burning equipment shall include the oil burner, motor, ignition equipment, controls, oil-storage tank, oil pipe and fittings, and all other items necessary for the complete installation of a fully automatic oil-burning heating system. All fuel-oil-burning equipment shall be approved by the Underwriters' Laboratories, Inc., and shall be installed in accordance with Pamphlet No. 31 of the National Board of Fire Underwriters.

a. Oil Burner: Oil burner shall conform to the requirements of United States Department of Commerce Commercial Standard CS75-42 when within the scope thereof. The oil burner shall be of the automatic type, suitable for handling Marine Class I Diesel oil without preheating. The burner shall be quiet in operation, and shall operate with a balanced flame so as not to localize heat in any part of the combustion chamber. The burner shall be capable of completely atomizing and effectively mixing the oil with the air so as to insure complete combustion. The air admitted shall be of sufficient quantity for complete combustion, but not of such quantity as to produce an undue percentage of excess air with the attendant high stack loss. The burner shall be designed for use of Marine Class I Diesel Fuel Oil.

b. Motor: The oil-burner motor shall be totally enclosed and shall be provided with thermal-overload protection. The motor shall suit the characteristics of the available electric service and shall conform to the requirements of the section on ELECTRICAL WORK: INTERIOR, of these specifications. The motor shall have sufficient capacity to operate the oil pump and fan so as to develop 100 percent of the specified furnace rating.

c. Automatic Draft Regulator: Automatic draft regulator shall be installed in the side of the smoke pipe. The regulator shall consist of a weighted and balanced damper of proper size for the furnace capacity. The damper shall open or close automatically as the chimney draft varies, so as to maintain a constant draft at the furnace outlet.

d. Oil Pipe and Fittings: Oil pipe shall be type K, annealed, copper tubing and shall be installed in accordance with the applicable requirements of the section on Pipe and Underground Tanks. ~~For Oil Storage, Fireable and other metal fittings to be installed as required.~~

17-08 CONTROLS: Controls for the furnace shall consist of a room thermostat, a combination high- and low-limit bonnet thermostat, and a stack switch. The room thermostat shall start or stop the oil burner automatically as the room temperature respectively falls below or rises above the predetermined point. The high-limit bonnet thermostat shall be arranged to take control from the room thermostat and shut off the oil burner whenever the bonnet temperature rises above the pre-determined high limit. The low-limit bonnet thermostat, set at approximately 90 degrees F., shall be arranged to cause the supply fan to start and run continuously whenever the bonnet temperature is above the pre-determined point. Provision shall be made for summer ventilation through manual operation of the circulating fan by a switch connected in parallel with the bonnet thermostat. A delayed-action stack switch or equivalent device shall be installed to shut off the oil burner automatically in case the oil fails to ignite on starting.

a. Bonnet Thermostats: Bonnet thermostats shall be an electric type and shall be suitable for operation in conjunction with the supply fan and heat-regulating devices. Bonnet thermostats shall be designed with an approximate high-limit range of from 100 degrees F. to 250 degrees F., with an approximate differential of 25 degrees F., and with an approximate low-limit (fan) range of 50 degrees F. to 200 degrees F., with a differential of approximately 25 degrees F. The thermostats may be combined as one instrument. Thermostats shall be provided with means of locking the settings. Each thermostat shall be equipped with a flange or other device to provide a space of not less than 1 inch between the sheet metal of the bonnet and the thermostat housing containing the electrical switches.

b. Room Thermostats: Unless otherwise shown room thermostats shall be the lock-shield type equipped with thermometers. Thermostats shall be designed to operate on not more than a 3 degree F. differential over a temperature range of approximately 55 degrees F. to 85 degrees F. and shall be set to maintain a room temperature of approximately 70 degrees F.

17-09 SMOKE STACK AND CONNECTION: Smoke stacks shall be constructed in accordance with details on the drawings and shall be provided with supports as shown therein. The furnace shall be connected to the stack or flue by means of smoke connection constructed of black iron or steel sheets not less than .0598 inch in thickness (16 gage). Suitable cleanouts shall be provided which will permit cleaning the entire smoke connection without dismantling.

17-10 FLEXIBLE CONNECTION: Flexible fireproof connections of asbestos or glass fabric, to prevent the transmission of vibration through the ducts to the rooms, shall be installed on the supply side of the heat exchanger, approximately where shown on the drawings, or as directed by the Contracting Officer. Cloth used for flexible connections shall be of proper weight and strength for the service required, and shall be properly filled to be rendered relatively airtight.

17-11 DUCTWORK: Sheet-metal duct work indicated on the drawings, for the heating of the building shall be erected in a first-class workmanlike manner, and shall be approved by the Contracting Officer. Ducts, unless otherwise approved, shall be true to the dimensions indicated on the drawings and straight and smooth on the inside, with neatly finished joints. The ducts shall be securely anchored to the building in the manner shown on the drawings and shall be so installed as to be completely free from vibration under all conditions of operation. The ducts shall be properly braced and reinforced with steel angles or other structural members spaced not more than 60 inches on centers. Sams and ductturns shall be installed as indicated. Slip joints shall be made in the direction of flow, and unless otherwise indicated on the plans, elbows shall have a center-line radius not less than one and one-half times the width of the duct. The sheet metal used shall be galvanized iron or steel, or aluminum. The thickness of the sheet metal size and spacing of the stiffeners used shall conform to table I and II, unless otherwise indicated on the drawings.

TABLE I - Weights and gages for duct metal

Longest dimension of rectangular ducts or diameter of round ducts (inches)	Weight of galvanized steel (pounds per square foot)	Galvanized steel sheet gage number	Thickness of aluminum sheet (inches)
Up to 12 -----	0.90625	26	0.025
Over 12 to 30 -----	1.1562	24	0.032
Over 30 to 48 -----	1.4062	22	0.040

TABLE II - Stiffeners for ducts

Surface width or height of ducts (inches)	Steel angle Stif- feners size (inches)	Center spacing (inches)	Weight of angle (pounds per foot before galvanizing)
Up to 24 -----	Not required ----- (Cross broken panels or 2 weights heavier Ducts)		
Over 24 to 48 -----	1 x 1 x 1/8 -----	48 to 60 -----	0.80

17-12 AIR OUTLETS: Outlets shall be the products of Tuttle and Bailey or approved equal.

a. Grilles: Grilles shall be constructed of sheet metal of approved composition and weight and shall have dimensions and net free areas as indicated on the drawings.

b. Registers: Registers shall be of the types noted on the drawing, of sturdy construction with adjustable vertical and horizontal vanes for double deflection and multi-shutter damper as indicated on the drawings.

17-13 DAMPERS: Splitter dampers shall be constructed of galvanized iron or steel sheets one gage heavier than the ducts in which they are installed, conforming to Table I. Dampers shall be provided with approved bearings at both ends of the shafts. Dampers shall be close-fitting and shall be provided with adjustment quadrants and locking devices. Supply volume dampers shall be as required to establish system balance and as shown on the drawings. Dampers shall be so designed as to offer a minimum of resistance to the flow of air.

17-14 INSULATION: Except when insulated at factory, the furnace shall be insulated with 1-inch thickness of asbestos air cell or thermally equivalent thickness of other suitable insulation approved by the Contracting Officer. The insulation shall be securely held in place in a manner approved by the Contracting Officer. If wire is employed for this purpose, suitable provisions shall be made to prevent the wire from cutting through the insulation at the corners of the ducts. The bonnet, plenum and supply duct in the furnace room shall be insulated as herein specified. All joints in the insulation shall be neatly filled with an insulating cement approved by the Contracting Officer. Ducts above ceiling and other similar spaces shall be insulated in the same manner.

17-15 ELECTRICAL WORK: All electrical equipment and installation shall conform to the applicable requirements of the section on ELECTRICAL WORK, INTERIOR, of these specifications.

17-16 PAINTING: Ferrous metal work not specified elsewhere to receive finish painting shall be thoroughly cleaned and given one coat of asphalt varnish. Ferrous metal specified to receive finish painting shall be primed as specified on the section on PAINTING, PROTECTIVE ON METAL, and will be as specified in the section on PAINTING, GENERAL, of these specifications.

17-17 TOOLS: All special tools necessary for the proper operation and maintenance of the heating equipment shall be furnished for maintenance and installed in the heater room in a manner approved by the Contracting Officer. Smoke-pipe and flue pass cleaners shall be provided. Wrenches shall be installed in hardwood containers.

17-18 OPERATION AND MAINTENANCE INSTRUCTIONS: Printed instructions covering the operation and maintenance of each item of equipment shall be posted at locations designated by the Contracting Officer. Upon completion of the work, and at a time designated by the Contracting Officer, the services of a competent engineer shall be provided for a period of not less than 3 days to instruct a representative of the Government in the operation and maintenance of the heating systems.

17-19 TESTS: Upon completion and prior to acceptance of the installation, the Contractor shall subject the heating system to such operating tests to properly demonstrate satisfactory functional and operating efficiency of the warm air furnace, duct system and automatic controls. Operating tests shall cover a period of not less than 6 hours for each system, and all tests shall be conducted at such times as the Contracting Officer may direct. All instruments, facilities and labor required to properly conduct the tests shall be provided by the Contractor at no additional cost to the Government, and all fuel, water and electricity required will be furnished by the Government.